NASA-University
Engineering Research Summit

Bioastronautics

Critical Technology Trends and Needs

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Bioastronautics Elements

All elements of Bioastronautics rely upon development and integration of enabling technologies.

Challenges: Orbital Space Flight

Astronauts experience a spectrum of adaptations in flight and postflight

Neurosensory
Neuromotor

Cardiovascular
Pulmonary

Endocrine

Musculoskeletal

Balance disorders
Cardiovascular deconditioning
Decreased immune function
Muscle atrophy
Bone loss

Challenges:
Exploration-Class Missions

- Understand stages of adaptation and establish countermeasures
- Stabilize and treat crew members as needed
- Predict and minimize exposure to radiation
- Maintain crew performance
- Provide regenerable/recyclable life support

Technologies of the Future

Today

Mechanical
Operator-dependent

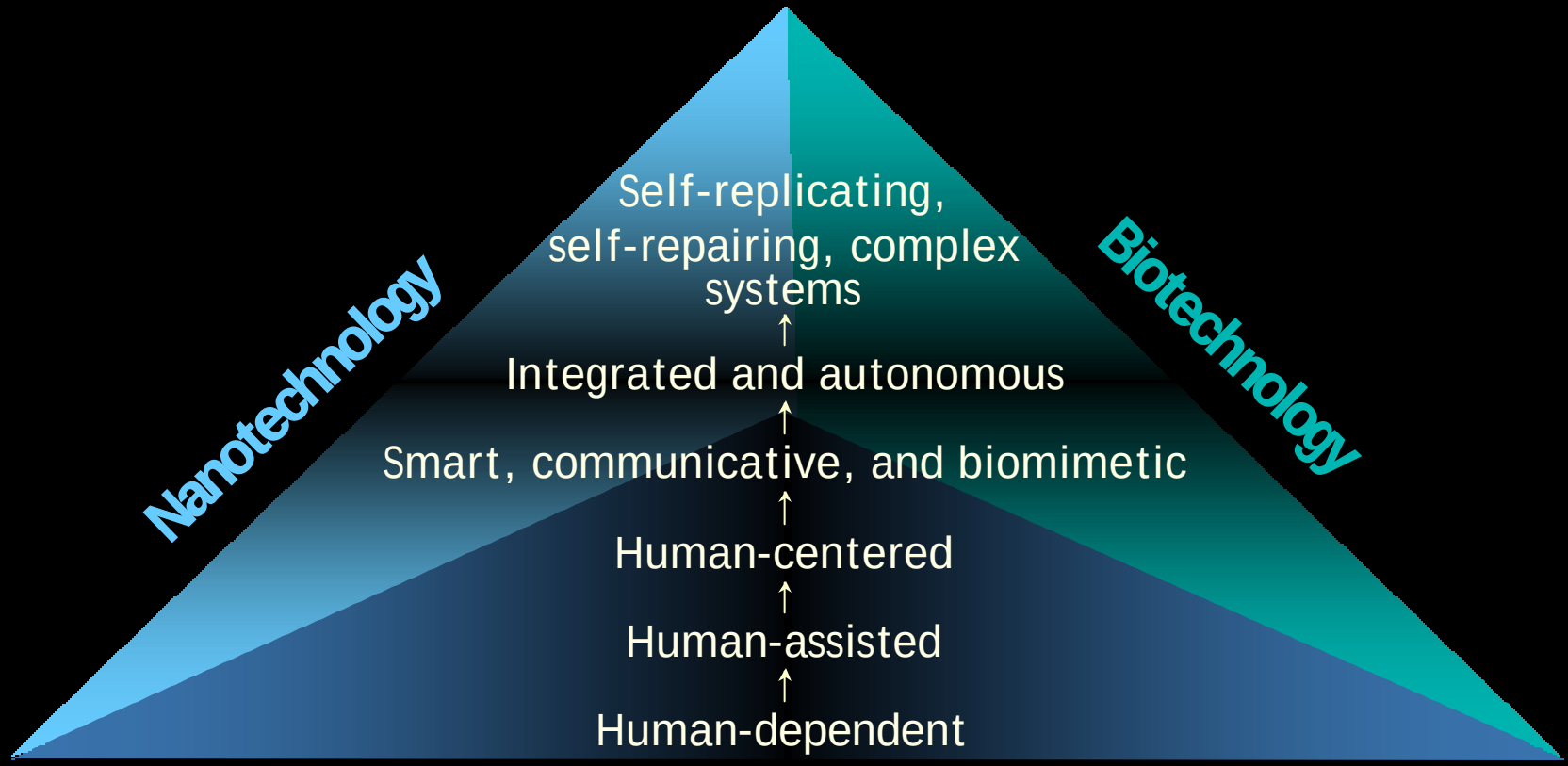
Technological Revolution

Tomorrow

Adaptive
Autonomous
Biologically inspired
Human-centered

Technologies of the Future

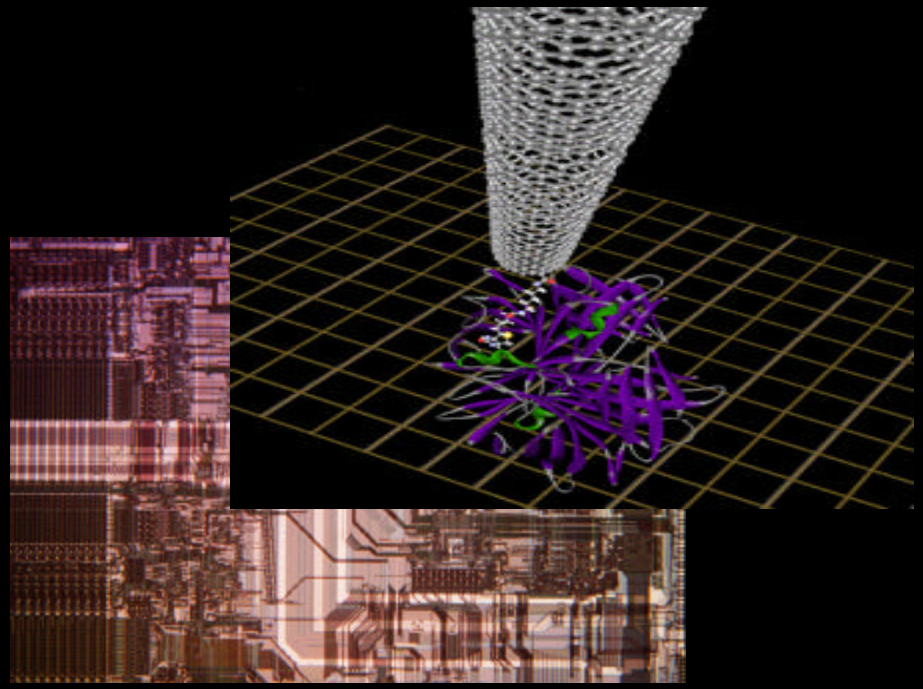
The next generation of technologies will draw from evolving knowledge in nanotechnologies, biotechnology, and informatics.



Nanotechnology
Research and Design on the Molecular Level

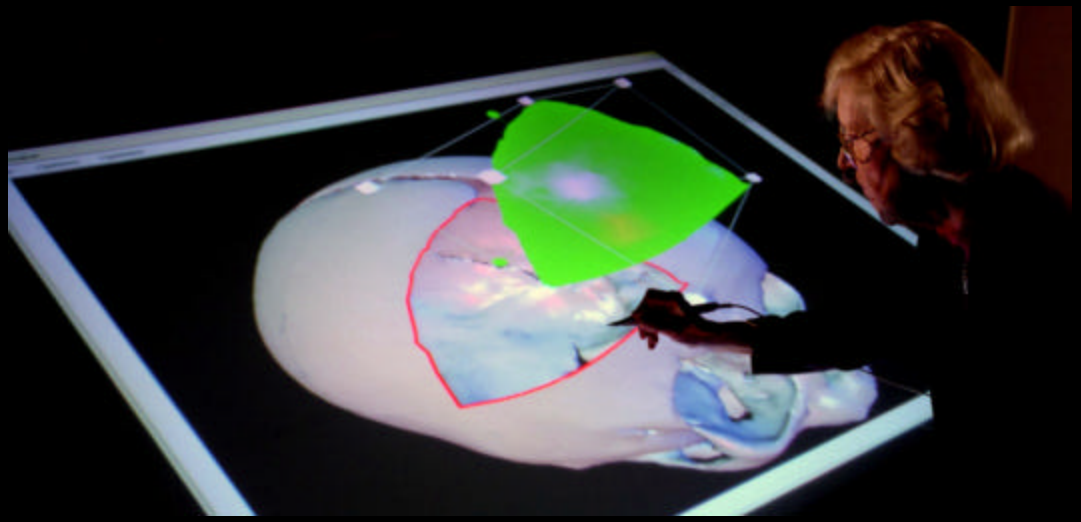
Life support
- Sensors and effectors
- Bioregeneration
- “Humans-on-a-chip”
- Biological niches

Medical care
- Diagnostic probes
- Treatment and delivery systems
- “Keyhole” surgery
- Tissue replacement



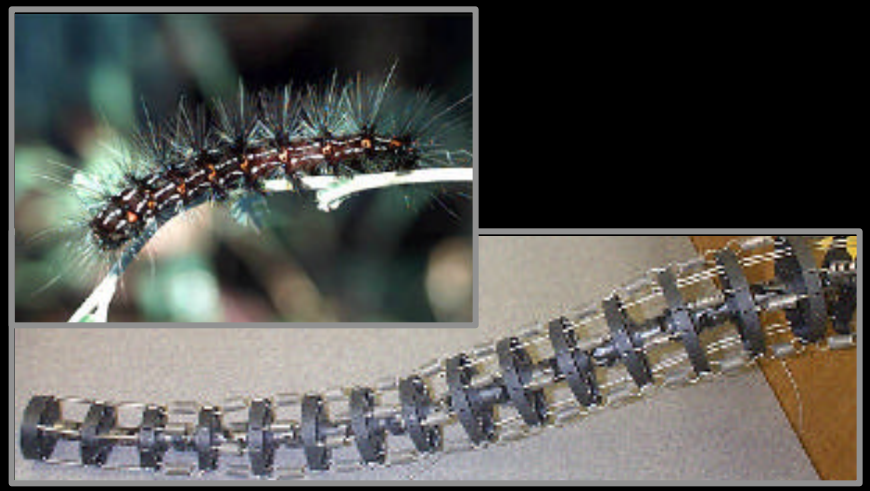
Informatics
Analyzing and Manipulating Data

- Biocomputation
  - Imaging
  - Training and simulation
- Telemedicine



Biotechnology
Drawing Inspiration from Biology

- Haptic "smart" systems capable of simple motions
- Self-repairing or –diagnosing systems based on genetic models
- Tissue engineering



- Imaging
  - X-ray
  - MRI
  - Ultrasound
- Sensors, effectors, and transmitters
  - Instruments
  - Analyzers

Critical Area
Adaptation and Countermeasures

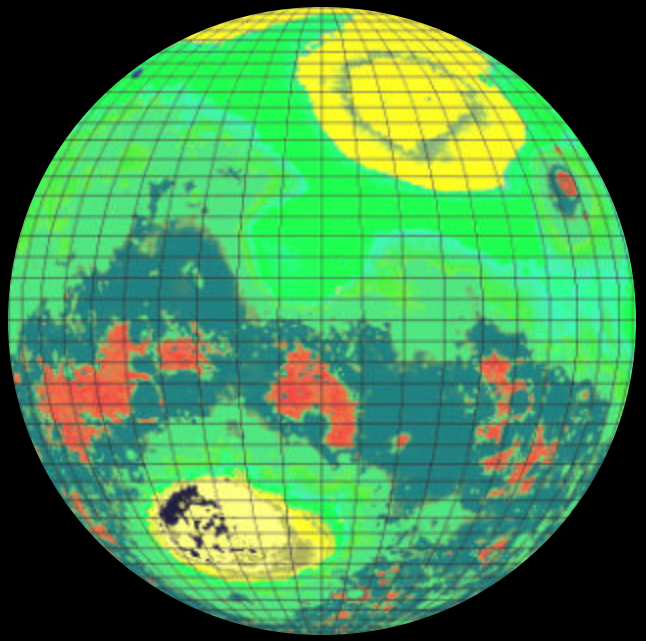
- Ingestible, implantable sensors
- Small, portable diagnostic equipment
- Molecular and genomic characterization of adaptation
- Pharmaceuticals and dietary supplements
- Exploration of artificial gravity as countermeasure
- Immersive VR/ systems for sensory-motor training and evaluation

Critical Area
Medical Diagnosis and Treatment

Technologies that significantly enhance

- diagnosis,
- treatment,
- long-term care, and
- medical informatics and training

Critical Area
Radiation



- Active, solid state, personal radiation dosimeter
- Biological dosimeter
- Early warning system for solar particle events
- Improved models for the radiation environment, shielding, and transport
- Chemical or biological modifiers and radioprotectants

Critical Area
Crew Performance

- Non-intrusive monitoring of individual/ group performance
- Adaptive user interfaces and displays
- Onboard systems for refresher training and skill monitoring
- Continuous assessment of mental status
- Personal communications and recreation through integrated system

Critical Area
Advanced Life Support

- Highly reliable, autonomous life support systems to provide:
  - breathable atmosphere,
  - potable water,
  - crop production and processing,
  - solid waste processing, and
  - thermal control
- Automatic detection and remediation of environmental
  - Microbial and chemical contamination in air, water, and food
  - Radiation events or cumulative exposure

Future Endeavors

Our capacity to explore beyond Earth's orbit demands the confluence of nanotechnology, biological inspiration, and informatics.